AN ORANGELESS MUTANT OF THE VARIED THRUSH AND ITS BEARING ON SEX COLOR-DIFFERENCES

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Preview.—From a study of a partially albino female Varied Thrush, certain inferences are suggested with regard to sex coloration, principal of which is that, in *Ixoreus,* the sex difference in pigmentation is quantitative rather than qualitative. Other inferences involved suggest:

1. A reciprocal or alternative relation between melanin and lipochrome pigments.
2. The controls which influence their deposition independently may affect one pigment or the other.
3. The lipochrome, because it acts as a stain, probably remains in suspension until the collapse of the cortex-forming cells.
4. The elements which form pigments must have been selectively stored in these cells while they were living cells.
5. A catalytic factor localized within the follicle, and stimulated to activity whenever a feather is lost, must direct the deposition of pigments according to the pattern of its kind.
6. The elements out of which pigments are formed must be present at all times in the blood stream.
7. Quantitative color readjustments may be stimulated by courting antics.

Text.—On March 25, 1921, there was brought into the Museum of Vertebrate Zoology, at Berkeley, California, an off-color bird of the species *Ixoreus naevius* which had been found alive in a nearby cañon with its wing freshly broken. It is now a specimen (no. 41851, Mus. Vert. Zool.) and was sexed as a female.

In definition, location, and contours of plumage pattern, this specimen agrees in every particular with normal females of the species, but there is a near total absence of the orange coloration, *in lieu* of which white or near white prevails. Only on the basal spots of the outer webs of the secondaries does the white bear more than the faintest trace of orange or buff, and even there it is little more than a wash.

The crown of this mutant, and in less measure the nape and cervix, are brown somewhat diluted in contra-measure by slate gray, which is the color of the saddle and rump. Thus, the dorsal areas, though they have a little brown tone anteriorly, lack the warm brown tone of normal females and more nearly resemble those of males.

In no respect do the gray or dusky areas seem subnormal in intensity nor has the absence of the orange factor intensified or blackened either the auricular patch or the crescent on the breast. The latter is obscure after the manner of other females.

It seems significant that, in this mutant female, absence of the orange-producing element should produce a dorsal coloration approaching that of a normal male. Can it be, in this species, that the sex differences in coloration are due, in part at least, to quantitative readjustments of the color pigments? Such an hypothesis is supported by the fact that the lipochrome pigments which are diffused, though in somewhat varying intensities, throughout the cortex of the pennaceous portions of the feathers of both the breast and the dorsal areas of the normal female, appear to be entirely absent from the back and rump of the male and, as compensation, seem to be more intense on the breast. Restated: compared with a normal female, a normal male

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appears to have more in quantity of the orange element ventrally, since there the color is more intense than in the female, and less of the orange element dorsally where its absence yields the slate grays.

Given a definite quantity of the orange or lipochrome element per individual of this species, whether male or female, a more equalized, less specialized distribution would tend to produce a browner back (orange over black) and a paler breast (the female plumage), while quantitative differentiation in distribution of the orange element favoring the breast and depriving the back, would tend to purify their colors to orange and slate respectively, in the areas where these colors normally dominate (the male plumage).

In distribution of melanin pigment, a somewhat different scheme characterizes the sex differences in normal adults. For, while the breast-collar is more intensely supplied with black or melanin pigment in the male than in the female (and this to the exclusion of the orange or lipochrome pigment abundant in the breast-collar of the female), this excess of black pigment is not at the expense of the dorsal areas. Though by less margin than in the breast-collar, the dorsal areas of the male are better supplied with melanin pigment than are the dorsal areas of the female. Perhaps, to a similar extent that the aggregate of melanin pigment is greater in the male, the aggregate of lipochrome pigment is less, for the added intensity of the latter in the breast of the male, which is not great, may fall short in quantity of an amount which would equal that normally present on the dorsum and rump of the female.

Increased intensity of melanin beyond a certain point, which does not appear to be the saturation point, seems rather suddenly to step the quality over from a feather (the back of a normal female), which combines lipochrome and melanin pigments (in no sense fused together), to a feather (the back of a normal male) in which the lipochrome is absent, at least so far as any tint of it is revealed by a microscope, either with dry mounts or in clearing media. As to saturation point, these gray feathers of the back of the male are less intensively pigmented with melanin than are the black feathers of the breast-collar.

The restrictive allocations of the lipochromes in the male, accompanied by an increase of intensity of the melanins in the areas in which the lipochromes have failed to appear, prompt the surmise that there may be a complementary or reciprocal or alternative relation between the two types of pigment which is physiological; possibly a repellent or prohibitive quality between them as a result of which the lipochromes disappear or, rather, fail to appear when the melanins exceed or are to exceed a certain intensity.

Since the melanin and lipochrome pigments are said to differ in chemical composition and to invade different portions of the feather structure, it is perhaps not surprising that the melanins should be normal in an individual whose lipochromes had failed to develop. Whatever the controls which influence the deposition of melanins and lipochromes, such controls were obviously separate and distinct in this mutant. Being separate, they can be subject to different physiological stimuli or react differently to the same physiological stimulus.

The lipochromes which color certain portions of the plumage in *Ixoreus* are diffused in the cortex without apparent granulation. It would seem that the elements out of which lipochrome pigments are metabolized may have remained in fluid suspension after the cells of the feather bud were formed. When this cell-structure collapses to form the fused cortex of the feather, the lipochrome appears to act as a stain. It is perhaps a further logical inference that when the chemical readjustment which induces the collapse of the cell structure occurs, the elements to produce the lipochrome stain have been already selectively stored in such collapsing cells. But the lipochrome stain need not be the chemical or mechanical result of the collapse of the cells, since lipochrome pigment is absent in similarly fused cortices of other feathers of the same bird.

Since the blood stream must be the agency of distribution of the elements necessary for pigment production, and since the blood itself, as far as we know, is without power selectively to distribute these elements, their lodgement must involve local stimuli or controls in the feather follicle itself which withdraw these elements from the blood and lodge them in certain cells of the growing feather.

Since, again, the pattern and color of any feather on the bird will be immediately duplicated at any time of the year that a feather is lost, it appears that all the materials out of which any color pigment is to be selected or synthesized in the feather follicle are at all times present in the blood stream.

Probably various factors enter into these follicular controls, for we may have in different species a single color maintained throughout the entire plumage of the bird, or limited to a single pteryla or feather tract, or to a portion of a feather tract, or to a single feather, a single web of a feather, or a mere spot on a feather. We may even find rhachis, barb, barbule, and barbicel, each with its different style of coloration consistently maintained throughout a single feather.

The function of such control factors appears to be that of a catalytic agent, active only under the stimulus of normal molt or of molt induced by the adventitious loss of feathers.

Because the control factor or catalytic agent is an integral part of each feather follicle and directly reflects activity within the follicle, it may be presumed to share modifications imposed upon the follicle by physiological influences from without. For instance, follicles which overlie muscles much used in the bird's activities, and hence abundantly supplied with blood vessels, might reflect such advantage by producing stronger colors through more efficient catalyzation.

Hit and miss as such inferences seem to be at the present stage of our studies, there is perhaps a hint of probability in them. For instance, the strutting antics of the courting male, in which it consciously displays certain feather tracts, may have effected by frequent repetition through countless generations, a physiological superiority in the feather follicles of the tracts so displayed, to the end that these more vigorous follicles yield the brighter colors.

Applied to the species under discussion, we find that in the male the orange pigments, which, incidentally, are the more fluid in chemical composition, concentrated on the breast and withdrawn from the back, while in the female the orange pigment is more generally distributed over the body. It is the breast, I dare say, that is displayed in the courting of this bird, though I have never been fortunate enough to observe these activities.

One's mind at once, of course, turns to the multitude of patterns and color combinations which the bird world presents, and to the unfeasibility of applying any general rule for color development to them all. Obviously, no such application is possible at present. But in any consideration of the theme herein stressed one must bear in mind that color in the various groups and in the various divisions of any group is not in the same stage of development. Nor has each group the same basic color trends out of which it is developing its color patterns, nor the same basic patterns on which to hang its colors.

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